Sustainable food systems: Considering the organic model

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A SUSTAINABLE FOOD SYSTEMS GUIDE

A Sustainable Food Systems Guide

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This guide covers a wide range of aspects of sustainable food systems and is intended for use by students and lecturers, scholars and teachers, as well as all interested participants and stakeholders of our food systems.

CONTENTS

INTRODUCTION

Johannes Kahl, Carola Strassner and Paola Migliorini

The United Nations – that international intergovernmental organisation that represents 99% of the world's countries and therewith represents the community of nations and humanity – has declared the 2030 Agenda for Sustainable Development [1] as the global roadmap for sustainable development. Within the 17 Sustainability Goals of this Agenda, two especially address sustainability of food consumption as well as food production and their interlinkages. Sustainable Development Goal (SDG) 2 is formulated as follows to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" and SDG 12 aims to "ensure sustainable production and consumption patterns". This interlinkage is explored by diverse scientific disciplines [e.g. 2] and recognized by the international community [3-6] proposing to take a food system approach to describe, analyse and set frames for action.

According to UNEP [7], taking a food systems approach allows the food chain activities to be linked to their social and environmental contexts. We characterise a food system as a defined set of activities and outcomes which gives the boundaries of the system [e.g. 8, 9]. Food systems can be recognized as complex social-ecological systems [10, 11]. According to UNEP [7] a food system also has an institutional (rules and regulations) and a jurisdictional, administrative (provincial, national, intergovernmental) dimension. For Ostrom [11] the challenge of taking a system approach to food is to identify and analyse the relationships among multiple levels of these complex systems at different spatial and temporal scales. Allen and Prosperi [10] take sustainability as an inherent property of a system.

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Sustainable food systems essentially need to meet the needs of a growing world population, environmental damage caused by agricultural practices has been well documented and ranges from air pollution (i.e., greenhouse gas emissions), soil degradation (erosion, loss of fertility, and salinization), water pollution caused by fertilizers and pesticides, destruction of aquatic ecosystems, and the loss of biodiversity at all levels . From an economic and social point of view too, agriculture has created many imbalances. Therefore, within sustainable food systems there is a global need for more sustainable agricultural practices, the integration of biological and ecological processes, minimizing the use of non-renewable inputs, more effective transfer of the knowledge and skills of food chain actors thus improving their self-reliance.

The question is how to make our food systems more sustainable and it is a complex question. It includes complexity of challenges both in environment and in all spheres of human activity (social, technical, etc.). Furthermore, the complexity of changes needed is part of the problem. Here we mean complexity in the sense of the number of interlinkages between individual issues and also the potential feedback loop effects down the lines.

With complexity of the problem we also mean that it is difficult to understand fully, to know all data, to know the full web of interrelated issues comprehensively. This complexity will carry over into learning and teaching. Developing approaches and tools for innovative education towards sustainable food systems is therefore a challenge. In this book we try to enter sustainable food systems from different entry points and introduce various important issues.

FOOD CULTURE

Angelika Ploeger

Food is connected to social contexts, cultural values, and identities. Food functions as a way to give structure to daily life and to ritualistically mark the passages from life stages or people from different countries of the world. The book written by Montanari [1] with the title 'Food is Culture' summarizes the different perspectives. Besides the necessity of a living organism to eat regularly, food for humans is the most intensive connection to nature, because with food we incorporate nature. That means harmful substances being used in agriculture or along the value chain (processing, packaging) have the capacity to be aggregated in food products and harm our health when being eaten. Therefore, trust has always been linked to eating food or being invited to celebrate welcoming and friendship. Moreover, food characterizes "One's place in the social system and is revealed by what, how much, and with whom one eats'' [2: 8].

The topic of Food Culture in relation to Sustainable Food Systems can be described by the following definition "In a sustainable food culture, human is aware of his/ her ecological and social responsibility while choosing, preparing, consuming and enjoying food. Sustainable food culture relates to useful, aesthetic and sensible aspects in the landscape and on the plate." [3: 36].

Figure 1 describes the importance of culture within the parameters of sustainability. Besides product quality, food security and especially food sovereignty as well as community are linked to best practice in agriculture and throughout the value chain. The reason to include the topic of culture in the Sustainability Flower tool developed by the Sustainable Organic Agriculture Action Network (SOAAN) is described as follows: "Culture and tradition originate from the land and

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Montanari M. 2015. Medieval Tastes, Food, Cooking, and the Table. Translated by Beth Archer Brombert. 280 pages Columbia University Press ISBN13: 9780231167864.

the people living on it, but regeneration from within, as well as healthy relevant linkage to, and support from, the outside world is necessary for continuity. Different cultures can also enrich each other. This is most appropriately achieved by each culture respecting the other and refraining from insisting its own attributes become the dominant paradigm." [4: 28].

Details including the description of underlining values and guidelines as well as practical examples are given on the topics of Personal Growth and Community Development, Food Security and Food which characterize culture within the sustainability flower.

An earlier Sustainability flower was created by the International Association of Ecology and Trade (IAP) which included the topic of culture, too (Figure 2). Since 2009 these guidelines have been developed by private institutions taking into account internationally recognised guidelines from, for example, the United Nations. The reason to develop a "sustainability flower" has been described as follows "The overall idea of the Sustainability Flower is to create a common understanding of which aspects are

Figure 1 The Sustainability Flower from the best practice guideline for agriculture and value chains as developed by SOAAN [4]

crucial for sustainable development in the agricultural supply chain. It offers a framework for assessing, improving and communicating sustainable development performance of an organization based on nine dimensions (soil, plants, animals, energy, air, water and societal life, cultural life, as well as economic life)" [5: V]. The parameters linked to Cultural Life are described as training and education, self-fulfilment and vitality, cultural rights as well as research and development [5: III].

The topic of Food Culture should gain more importance as part of holistic food systems and should be introduced into education and research agendas.

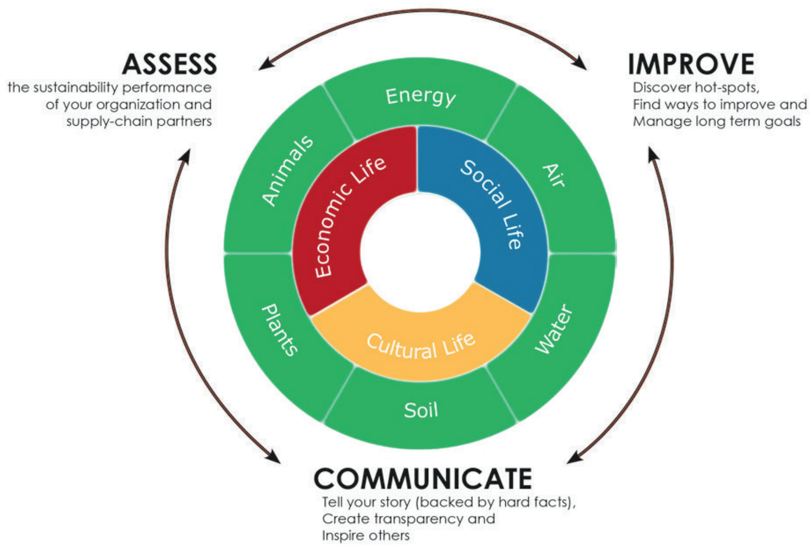

Figure 2 IAP Sustainability Flower including management (with kind permission from Anne Bandel, Soil and More Foundation)

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FOOD QUALITY: SENSORY PERCEPTION OF FOOD

Angelika Ploeger

Results of surveys show that important food quality criteria are perceived by our human senses such as outer appearance, smell, texture and taste. Already as an embryo a human being gets the information for preference of food or odour by means of the mother´s diet [1]. Therefore, the question of preferences of food reflects the food behaviour of the person being asked and not just the quality of a product itself.

In general, one can define the terms as follows: Sensory evaluation is the main method of analysis in sensory science and is defined as "a scientific method used to evoke, measure, analyse and interpret those responses to products as

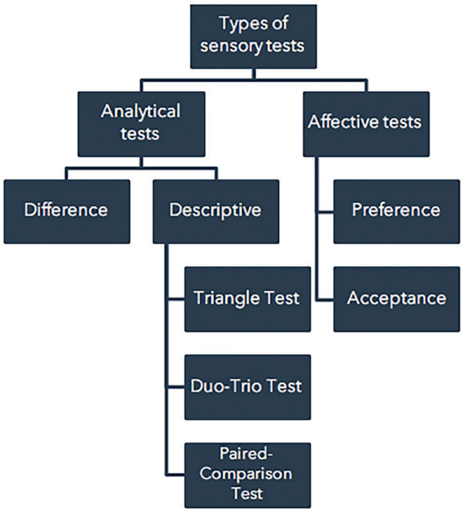

Figure 1 Types of Sensory Tests [3]

Table 1 Types of sensory tests with choice of the parameters based on the aim of the test [3]

Test aim	Assessors qualification	Number of assessors	Statistical method		
			Comparison to a known order (assessors performance)	Order of products unknown (products comparison)	
				2 products	more than 2 products
Performance assessment of individuals	Selected assessors or experts	Unlimited	Spearman or Kendall Test	Sign Test	Friedman Test
Performance assessment of a group	Selected assessors or experts	Preferably 12 to 15	Page Test		
Product assessment on a descriptive criterion	Selected assessors or experts	Preferably 12 to 15			
Product assessment on hedonic preferences	Consumers	Minimum 60 per group of consumer type (cell and segment)			

perceived through the senses of sight, smell, touch, taste, and hearing" [2]. Using sensory science as a methodology for quality assessment of food means to rely on norms for sensory methodologies (ISO). ISO standards describe the requirements and statistics to be used to present reliable results. Combining sensory data with physical and chemical data of the product and process variables enables companies to deliver optimal consumer benefits. Sophisticated statistical methods have been developed to support these applications (sensometrics). Neuroscience plays a role by helping to explain, for example, flavour perception as functional magnetic resonance so identifying areas of the brain that respond to a particular stimulus in the food.

There are many different tests described in sensory science to give answers to questions in science, product development or consumer perception (Figure 1, ISO 8587 and Table 1).

To establish your own panel for sensory analyses as a tool to determine food quality please read ISO 8586 (2012): Sensory Analysis – General Guidelines for the selection, training and monitoring of selected assessor and expert, sensory assessor [4].

The vocabulary for describing food quality parameters has been given in ISO 5492 [5]. So, for taste one is talking about basic taste - that means any one of the distinctive tastes: acid/sour, bitter, salty, sweet, umami. Examples for correct descrip-

Table 2 Examples of Sensory Attributes [5]

(a) Appearance (visual perceptions)
pale spotted shiny colourless artificial bright marbled
dark light hazy unnatural irregular watery harmonic
(b) Shape (visual perceptions)
damaged broken smooth edged wrinkly firm
flat cracked hollow round mashed shrunk
(c) Smell (olfactory perceptions)
old balanced earthy fresh rancid mouldy
aromatic caramelized rotten fishy smoky piercing
(d) Taste (gustatory perceptions)
astringent aromatic bitter metallic mild smoky raw soapy sweet gluey
old balanced burned cheesy oily salty spicy sour musty fruity
(e) Texture (haptic and auditory perceptions)
creamy crumbly fibrous firm rubbery sticky crispy chalky oily juicy
mushy elastic smooth fatty woody lumpy grainy floury plastic slimy

tions of attributes are given in Table 2 according to ISO 5492.

In view of Sustainable Food Systems, sensory quality parameters of food are important because they characterize the diversity of different varieties of food (e.g. apple cultivars) and link emotions and consumption of food (e.g. re-purchase). Tools from sensory science (concerning smell, taste, texture) can be used for product development in industry and especially in small and medium-sized enterprises and on-farm during the processing steps to guarantee a safe and tasteful product which is consumed and not wasted.

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SUSTAINABLE DIETS

Susanne Bügel

The world's population is increasing and people live longer. It has been estimated that the number of people will grow from 7 billion in 2017 to nearly 10 billion in 2050, with more people living in the cities and will become wealthier [1]. Urbanization and increased income have a tendency to change dietary consumption from more plant-based towards more animal-based food patterns pushing towards a more western-style diet. Western-style diets are linked with increased morbidity and mortality; furthermore, the way in which food is produced, distributed and consumed today also increases health care costs to society and environmental damage [1]. It is reckoned that food systems in the 2010's contribute to 20-30% of greenhouse gasses; 70% of water utilization and have immense impact on the loss of biodiversity, destruction of natural habitats and land degradation [2]. This necessitates demands for optimal and more sustainable food production, nutrition security and dietary patterns [3].

FAO has calculated that if we do not change dietary patterns, food waste, etc., in order to satisfy the needs of a growing and richer population with an increased demand for animal protein, food production will have to increase by 60% [4]. However, if we change habits, the current food production is sufficient to feed the estimated 10 billion people in 2015. This can be achieved by, amongst others, changing diets and improving food production efficiency and decreasing food losses and waste.

In 2015, the United Nations accepted the 2030 Agenda for sustainable development resolution with strong emphasis on healthier and more sustainable food and diets. A sustainable diet has been defined by FAO as being a diet with low impact on the planets resources and the environment, including respectfulness for biodiversity and animal welfare and contributing to an adequate diet that promotes healthy life. Furthermore, a sustainable diet also features characteristics such as cultural acceptability, accessibility, economic fairness and affordability [5].

There is increasing evidence that environmental sustainable dietary patterns are consistent with good health [3]. The food choices needed in order to become more sustainable are highly compatible with existing official dietary recommendations and guidelines. The characteristics of such diets have been outlined by Garnett [2]. These characteristics call for diversity, balance between energy intake and needs, primarily plant-based foods, moderate intake of meat and dairy products, small quantities of fish and aquatic products from certified fisheries, very limited intake of fat, sugar and salty products; oil and fat intake with beneficial omega fatty acid n-3:6 ratio and tap water in preference to other beverages [2].

One way forward to a more sustainable and healthy future is to generate and disseminate food-based dietary guidelines that include both health and sustainability issues. In 2016 only four out of 83 countries with food-based dietary guidelines included sustainability in their guidelines, namely Sweden, Germany, Brazil and Qatar [3].

The above mentioned characteristics of a healthy and sustainable diet are very much in accordance with diets that are considered healthy diets, such as DASH (Dietary Approaches to Stop Hypertension), the Mediterranean diet and the New Nordic Diet [6–8]. Many studies have shown that adherence to a traditional Mediterranean diet, characterised by lower meat consumption and high intake of vegetables, fruits, seafood and olive oil is associated with a significant reduction of mortality risk [9]. Hence it has been recommended in countries beyond the Mediterranean too. Adherence to the traditional Mediterranean diet pattern is declining in the Mediterranean area and in other regions of the world it is very low [10]. The New Nordic Diet was invented as a consequence of this, highly inspired by the Mediterranean diet pattern, but using Nordic raw material [11]. The research studies performed so far indicate that the New Nordic Diet may have health beneficial effects similar to the Mediterranean diet [7]. Furthermore, lifecycle analyses have shown that the New Nordic Diet was both healthier and more sustainable than an average Danish diet [12]. The New Nordic Diet contained 35% less meat than the average Danish diet and more whole-grain, nuts, fruits and vegetables. Overall, when monetizing and summing up all the environmental impacts the diets may have, the socioeconomic savings related to this diet shift was 32% of the environmental cost of the average Danish diet [12].

The principles used for designing and describing the New Nordic Diet can be used in any region of the world and it is therefore well suited as a model for a sustainable, healthy diet [13].

To achieve a more sustainable diet we should eat a highly varied diet consisting of more plant-based food and less meat-based food, choose locally grown foods, choose products when in season and reduce waste. To reach these goals we need to implement coordinated approaches in the educational system, to educate and empower teachers and students and to break down disciplinary boundaries in order to address the complex issues related to sustainable food production and dietary habits. In other words, we need to integrate sustainable diets principles in our daily activities and accelerate the implementation of sustainable diets at community levels by capacity building and empowerment of educators and students.

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Innovative Public Organic food Procurement for Youth (iPOPY) A CORE Organic Research Project (2007-2010)

FOODSERVICE AND SUSTAINABILITY

Carola Strassner

The question where people eat – the Point of Meal – is as important to sustainable development as is what they eat. Foodservice covers the full range of eating outside of home contexts throughout the human lifecycle: kindergarten, school, college or university, workplace, and leisure as well as hospital, clinic, home, prison and military settings [1]. Typically foodservice operations are broadly classified into public and commercial enterprises. The former include meal provision systems in educational, healthcare and social settings while the latter include the wide variety of restaurants and hotels.

Public food service is closely linked to public procurement and it is here that endeavours for a more sustainable development are concentrated [2], such as within the EU Green Public Procurement Criteria for Food and Catering Services and UNEP's Sustainable Public Procurement Programme of the 10-Year Framework of Programmes (10YFP SPP Programme). A second area of focus emerging is that of healthy meals, as public foodservice carries a special responsibility for nutrition-related health and health promotion. Tools commonly employed here include dietary guidelines, ideally food-based dietary guidelines that include both health and sustainability issues [see the section on Sustainable Diet in this booklet] but also various footprint-calculated recipes (e.g. land use, water use, CO2e emissions).

School meal systems have received much attention, given their potential roles in public health outcomes (especially the future development of nutrition-related diseases such as obesity, diabetes, heart disease and others) and literacy skills opportunities (food literacy, ecoliteracy, etc.). Besides food quality and sources, the dining experience, the professional development of staff and the direct link or integration into the education programme are aspects tackled. 'Rethinking School Lunch' is a planning framework developed by the Californian Center for Ecoliteracy which gives a comprehensive overview.

Commercial foodservice operations can often be regarded in connection with their location and even function in a tourism context, whether that is hospitality, travel or leisure. The impacts of this sector are sometimes highly positive (employment opportunities and social development) and sometimes highly negative (environmental destruction and labour relations). Considered as one of the main economic sectors worldwide, it is also subject of a UNEP 10YFP programme on sustainable tourism in order to address the significant challenges on the road to a sustainable transformation. The Sustainable Tourism Gateway is a source that provides links to tools, strategies and checklists for eco-tourism.

One model specifically developed to address sustainability in foodservice is the 'sustainability house' model [3: 12-20]. It encompasses the original three pillars (economy, ecology, society) and adds two more on the basis of this sector's unique features (health and attractiveness). Economic sustainability of an operation is considered the foundation of the house, health and attractiveness the supporting walls, and ecology and society as the protective roof. The model provides a framework for a systematic consideration of all critical issues. These cover a wide range that includes addressing energy efficiency, water use and cycling, construction, design and cleaning.

Two further areas in particular are sustainable food sourcing and waste management. Sustainable food sourcing explores the farm-to-fork paths of produce and their impacts. This brings labels and standards into the fore, as these provide a suitable basis for decision-making. Categories include organic, fairtrade, artisan, sustainably fished and local purchasing. Through such implementation effects may be achieved, for example, externally in biodiversity protection or local economy support and internally in lowering operational overheads. Finally, waste management helps close the loop [4]. The old adage 'reduce, reuse, recycle' can be applied to both food and non-food in foodservice. Resource use (energy, water, etc.) can be reduced, and much can be recycled: packaging, paper, fryer oil into fuel and organic waste into compost.

In conclusion, foodservice provides plenty of scope for sustainability initiatives in all spheres and there are many examples of good practices across all typologies.

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SUSTAINABLE FOOD SYSTEMS: CONSIDERING THE ORGANIC MODEL

Johannes Kahl

The global food system is facing a number of challenges which have been identified from various perspectives. From their analysis of the global food system Gladek et al. [1] concluded that the "preservation of ecosystems and the future wellbeing of the human population are all centrally dependent on a structural transformation of the food system towards a sustainable and resilient state". Therefore they suggest that special attention should be given to the consideration of system's behaviours and impacts for transformation towards enhanced sustainability and resilience. UNEP [2] link global challenges of our food system, a system approach and the Sustainable Developmental Goals (SDGs). Taking a system view, for the working group around Westhoek [2] it seems evident that "sustainable food systems are not only about sustainable and efficient food production; the key challenge is to be effective in terms of food security, livelihoods and human health". The High Level Panel of Experts [3] contributes with a consensus definition of what a sustainable food system are: "Sustainable food system (SFS) is a food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised." When transforming the current industrial model and "simultaneously developing alternative food systems" [4], the organic food system may be taken as such an alternative model [5]. The underlying aim of the organic movement was and still is to create a sustainable and healthy food system with a focus on primary production (agriculture), but one that also includes processing and the entire value chain as well as distribution and organic consumption issues and ethics. Vergragt et al. [6] identified enabling mechanisms towards sustainable food systems from the actors' perspective, which directly address organic food systems aspects such as greening the supply chain, producing responsibly, certifying and labelling, marketing ethically, and buying responsibly. Daugbjerg & Botterill [7] discuss different values related to global trade. They take organic as one of a number of examples when focusing on the involvement of governments in organic food systems.

Visions, indicators and parameters have been developed for the organic agriculture and food production system and are further defined by international standards and regulations. Organic agriculture has been practised for one hundred years and takes into consideration the natural environment, animal welfare and food quality as well as public health issues [8]. Organic agriculture has spread to nearly all regions in the world [9]. Today it is described in the Codex Alimentarius and its vision is reflected in international standards (e.g. IFOAM – Organics International, https://www.ifoam.bio/) and defined at the regulatory level e.g., in Europe, USA, Japan and numerous other countries [9]. In Europe, the organic label is recognized by European consumers and associated with an eco-friendly and health-promoting food system [e.g. 10, 11]. The organic food system offers an example of successfully combining sustainable food production and sustainable consumption patterns within one system [5]. Based on central findings through surveys and other studies around the world, consumers and producers of organic products share specific attitudes to food that are mainly oriented towards health and environment [e.g. 12, 13]. Here organic food and farming may be described as a global food system with local multistakeholder initiatives [9]. The change in consumption patterns is a crucial issue in the transition to sustainable food systems. The dietary pattern of organic consumers seems to be closer to healthy dietary patterns as well to the sustainable diet concept [14, 15]. One of the underlying determinants of organic agriculture and food production is the link between sustainability and health. A major task to be undertaken is to describe transformation processes of organic food systems under various conditions, identify drivers and translate these learnings into tools that enhance and reinforce the necessary changes in lifestyles.

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ECOSYSTEM SERVICES, BIODIVERSITY AND FOOD PRODUCTION

Eve Veromann and
Linda-Liisa Veromann-Jürgenson

During the last decades, the pressure to increase food production has continuously risen because of the exponential increase of the human population as well as a general increase of prosperity that sets higher demands on the food amount, diversity and quality. In addition to food production, also urbanization, competing land use for non-food crops and climate change have altered the suitability of farmland for use. It is well established that intensive agriculture and the associated land-use change is a major driver of biodiversity loss. Intensive agriculture threatens not only biodiversity but also has a devastating impact on soil biota and fertility, water quality and availability, and decreases the availability of several ecosystem services connected to food production. Intensive agriculture increases soil erosion and the contamination of the environment, and also the final products of food and feed with synthetic pesticide residues. Conversely, the principles of sustainable agriculture are based on the integrated system of plant and animal production practises without relying on synthetic pesticides, fertilizers and genetically modified seeds; and on the understanding and enhancement of ecosystem services.

Ecosystem services are the benefits, both direct and indirect, which ecosystems provide for human gain [1]. These are divided into four groups (Table 1) and cover all of the needs of mankind for sustainable agriculture and healthy living. An example of this is a traditional method of woodland management whereby sections are harvested on a rotation basis giving rise to a coppice. Such a plant community is often under-appreciated, but it provides carbon sequestration, photosynthetic products, habitat for birds, small mammals and arthropods (further providing pest control, aesthetic and spiritual value), regulates soil-water relations, acts as a windbreak, captures air pollutants and reduces noise.

In agricultural production, most valued ecosystem services are connected to regulation where farmers can have monetary gains from higher yields due to higher soil fertility and pollination as well as pest and disease (bacterial, viral, fungal) control thanks to predatory arthropods and soil suppressiveness (i.e. a very low level of disease development even though virulent pathogens are present). Additional financial rewards are gained from lower erosion and fewer extreme weather events occasionally destroying whole harvests.

Biodiversity is the diversity within and among all living organisms (e.g. animals, plants, fungi, lichens, micro-organisms) at the species, genetic and ecosystem levels. All ecosystem services are based on biodiversity: without this, there cannot be sufficient benefits from any service category. Unequivocal evidence has been found connecting biodiversity loss to a reduction of the efficiency of biologically essential resource capture, biomass production (yield), decomposition and recycling of nutrients (soil fertility) [2].

Biodiversity is paramount in ecosystem functioning. For example, heterogeneous landscapes with high proportions of non-cropped areas and semi-natural habitats supporting high biodiversity have been shown to provide higher pollination and pest control services by naturally occurring arthropods and vertebrates reducing agricultural costs per hectare. Biological diversity plays a crucial role in agriculture too. For instance, crop genetic diversity mitigates the risks caused by the environment and climate conditions. Moreover, the susceptibility level to pests and diseases, as well as soil and water demands of different cultivars are variable. If farmers have a diverse crop selection at the genetic and species level in their farmland over the crop rotation period, they diminish the risk of having a lean year.

In conclusion, agriculture provides provisioning ecosystem services indispensable to human wellbeing. Ecosystem services sustain agricultural productivity and resilience, while biodiversity is crucial for continued and sufficient services provided by the ecosystem. Sustainable agricultural practices conserve, enhance and use the below- and aboveground biodiversity, while decreasing environmental and food contamination with synthetic pesticides and fertilizers. This approach improves the availability of ecosystem services, increases local biodiversity and resilience to climate change, ultimately serving mankind considerably more in the long-term than intensive farming systems.

Table 1 Ecosystem service categories modified from the Millennium Ecosystem Assessment [1]

Provisioning	**Regulating**	**Cultural**

Products obtained from the ecosystem
• Food from:
  ○ Agriculture
  ○ Seas and oceans
  ○ Freshwater systems
  ○ Forests
• Freshwater
• Raw materials:
  ○ Fuel
  ○ Wood
  ○ Fibre
  ○ Plant oils
• Medicinal resources
	Benefits obtained from the regulation of ecosystem processes
	• Climate regulation
	• Air quality
	• Carbon sequestration and storage
	• Erosion control
	• Control of pests and pathogens
	• Pollination
	• Waste-water treatment
	• Soil fertility
	• Moderation of extreme events: flood control, landslides etc.
		Nonmaterial gains obtained from the ecosystems
		• Aesthetic and inspiration for culture, art and design
		• Educational
		• Recreational
		• Mental and physical health
		• Tourism
		• Research
		• Spiritual experience and sense of belonging

Habitat and supporting *Services necessary for the production of all other ecosystem services* • Biodiversity and genetic diversity maintenance • Nutrient cycling • Primary production (photosynthesis) • Soil formation • Habitat for species		

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FOOD VALUE CHAINS

Teresa Briz

The entire world is facing new situations regarding competition in the food chain. It is no longer a matter of production or consumption, but an overall look at the whole food chain. All the links which belong to a food system need to be connected and need to establish a strategic collaboration to fulfil their needs and achieve mutual benefits. One of the main goals is agreed to be sustainability. If the food chain is not sustainable, it will not resist any market changes and will not survive in time. That is why it is so relevant to consider sustainable food chains from the beginning until the end. Considering that there are substantial gaps between developed and developing regions, nevertheless both of them need to be sustainable.

In developed countries the challenge is to ensure the adequate share of the added value between different stakeholders. There is a growing competition between food value chain participants as a consequence of globalization and consumers' demand for market transparency and high quality products.

In developing countries, food safety and food security need to be implemented on a wider scale and the problems that appear along the food chain (e.g. logistic problems or lack of transforming industries) need to be solved in order to ensure an efficient chain.

In these different scenarios (developed and developing countries), the global view of the food value chain is crucial, from consumer to producer, or producer to consumer. Food value chains are characterized by a high degree of complexity due to many partners from producer to consumer [1]. It is not enough to focus on one of the links without studying the previous or the following stakeholder. It would give a partial and distorted image of the chain, since the food value chain is as strong as its weakest link.

The food system is one of the most complex ones in the global economic system, that's why it creates inefficiency problems, lacks transparency and dominant positions in some cases. This adds up to a huge social concern, since it deals with a basic issue, nutrition, and sometimes the decision-making process is affected by this issue. For example, the use of corn (maize) as a bio fuel affected the market and prices rose for basic products of a regular diet.

There is traditionally a supplying phase of food products in the value chain from producers to wholesale local markets, which are the linked to larger wholesale markets (usually located in large cities). Finally, the retail link, through all its varied possibilities, reaches consumers.

This is the usual food products chain whereas for industrial products the starting point for the chain is the factory, so the length of the chain is shortened. This is why food value chains have different performance and measures to adopt to achieve greater sustainability.

Lastly, the normalization processes and the use of information and communication technologies (ICT) facilitate the existence of parallel channels, such as direct channels from producer to consumer that provide efficiency in the competitive scenario.

Food value chain management requires an adequate planning from the beginning: for a company that means setting its goals (e.g. maximize benefits, maintain labour, gain market quota, improve market penetration), and their prioritisation. Then, the decision-making process takes place, implementation and the evaluation of the results.

In the decision-making process we need to study both the horizontal and vertical chain perspectives, that is, the view of the whole network and the key performance indicators (KPIs) that may determine the success or failure of the transaction [2].

Following Lazzarini et al. [2] the existing relationships between different network partners are of increasing importance to understand and model the complexity of a food value chain, especially the industrial links. Market orientation not only has to account for the horizontal chain axis, but also for the vertical axis - the entire network where companies operate.

The evolution of the socioeconomic framework leads to a competition between value chains, not between companies, so it forces companies to coordinate for efficient value chains in order to survive. The long-term and mid-term vision of a company network would allow it to share knowledge and risks, improve confidence and reduce transaction costs. Each stakeholder needs to get the adequate share of the added value they have provided to the final product, following win-win relationships.

Last, but not least, the application of a theoretical framework has to be considered: Structure, Conduct and Performance paradigm whenever it is possible (with statistical quantitative data or complementary with a qualitative analysis).

The only possibility for food chains to succeed is implementing a global vision which includes all stakeholders and their particularities. There may be changes in the society, new regulations, technologies and information systems, management and structure, among other changes, but as long as it is sustainable and the added value is shared, then, the food system will perform well.

SUSTAINABILITY ASSESSMENT OF AGRI-FOOD SYSTEMS

Paola Migliorini

Agri-food sustainability is a very complex and large issue. In particular the agricultural and food sectors are multifunctional in that they produce both goods and services, and sustainability is a multi-scale and multi-faceted issue whose parameters often conflict with one another. Therefore, a multi-dimensional (environmental, economic, social and cultural) assessment using multiple criteria and sets of indicators that consider different levels of analysis (farmer, producer, consumer, government and international agreements) is useful but difficult and critical as it depends on the perspective taken when looking at the system.

The concept of sustainable agriculture as described by Hansen [1] considers two visions: (a) sustainability as a philosophical approach; (b) sustainability as a system property. In the former, sustainable agriculture is described as an umbrella term encompassing several alternative approaches, paradigms and values as compared to conventional agriculture. Following on this a series of alternative strategies and good practices are identified as sustainable (e.g. large crop rotation, intercropping, soil protection against erosion, organic nutrient management) while others are not. In the latter, the sustainable agricultural system is defined as one that fulfils several goals over time. These goals generally include some expression of maintenance or enhancement of the natural environment, provision of human food needs, economic viability and social welfare. According to this second vision Conway [2] defined sustainability as resilience, namely "the ability of a system to maintain productivity in spite of a major

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disturbance" and he suggested the measurement of four system properties (productivity, stability, sustainability and equitability). The second vision involves determination of the system in terms of space (the boundaries of the system) and time (the direction and degree of measurable changes in system properties through time).

What is determined "sustainable" is also culture-oriented and the questions of "sustainable for whom and in which sense" are relevant as there is no solution that optimizes all the possible criteria of performance for all the relevant actors (who decides who are the relevant actors and how?).

Any assessment implying a value judgment (such as 'good' or 'bad') cannot be made by the application of an algorithm within an optimization protocol. Rather, value judgments must be made within a participatory process of multi-criterial assessment [3]. In recent years, a number of different methodologies, instruments and tools have been developed to assess sustainability in the agri-food system [4] at different scales (global, international, national, regional, farm and plot levels). The oldest of these methodologies refers to only one dimension, i.e. the environmental and uses agroecological indicators [5] or Life Cycle Assessment [6]. More recently, the need to integrate the different dimensions of sustainability (environmental, economic, social and cultural) contributed to developing a holistic approach with specific indicators for each dimension [7, 8].

The selection and method of calculation of indicators play a key role within the different approaches adopted for assessing sustainability. They can be qualitative or quantitative. According to the definition of sustainability chosen, indicators are adequate tools to monitor the performances of Best Practices and progress toward meeting predefined goals of given units over time. However, depending on the purpose for which they were designed, instruments vary in scale (geographical area), level (thematic scope), reference evaluation (of the product, the company, the agricultural sector) and precision (addressed to researchers or politicians). As a consequence, tools designed for different purposes and goals can get to different results for the same assessment. In fact, the use of several indicators as a tool for decision-making, risks jeopardizing the actual interpretation of the state of a system. The more recently developed methodologies try to integrate different aspects of sustainability by developing a Sustainability Index. There are different examples of an integrated approach to assess sustainability [9] using three central steps: selection and calculation, normalization and weighting, aggregation of indicators.

According to the system approach, a food product is analysed in the following phases: production and supply of raw materials, production and processing of food, packaging and distribution, sales and consumption, and final disposal in three (environmental, social and economic) or more (additionally political, cultural as well as food quality and accountability) sustainability dimensions. One promising approach is the Sustainability Assessment of Food and Agriculture - SAFA of the FAO.

Each method available has several steps in order to conduct the assessment and each step implies several decisions and choices to be made a priori (Table 1).

The first step is to define the sustainability issues (phase 1). This implies including different points of view (and excluding some others) and deciding the system boundaries both in space (i.e. farm level) and time (for how long it should be sustained? 1 year, 10 years or 100 years?). Then there is a need to identify what should be sustained and specific issues in each dimension, according to the most critical points and goals to be achieved. For each issue, several indicators are selected.

The second step (phase 2) is to decide how to express a judgement. There are different possibilities but the expression is always a comparison as sustainability is not objective but always relative. So we can compare: according to time frames ("this farm is more sustainable today than 10 years ago"); different systems (e.g. in homogenous farming systems in the same region those farms are more sustainable than those others); the results of the indicators in relation to an optimal objective (e.g. the optimal level of this indicator is X and the system has strong sustainability if above the optimal); the results of the indicators compared to a threshold limit (e.g. the threshold limit of this indicator is Y, and the system has weak sustainability if just above this limit).

The methods of calculation of indicators should be appropriate to the defined sustainability goals: very detailed and precise if it is for research purposes; low cost and fast if for farmers' assessment; condensed and easy to communicate if for consumers or policy makers. Then all the indicators have to be calculated and thus assess the system.

The third step (phase 3) includes reflecting on possible alternative management systems and identifying policy measures that can imply positive feedback on specific aspects of sustainability. Finally, all these relevant results are presented and discussed.

Table 1 Procedural steps to conduct sustainability assessment (modified from [5])

1. DEFINE THE SUSTAINABILITY ISSUES	• Definition of Sustainability concept and dimension (who?) • Definition of system boundaries (space and time) (where and for how long?) • Identification of issues related to sustainability in the system (what?) • Identification of detailed critical points and objectives to be achieved (What should be sustained in each sustainability dimension?) • Indicators selection (how?)
2. EVALUATION OF THE SYSTEM	• Settle a comparison layout (How to judge?) o System evolution over time o Comparable systems o Optimal objective o Threshold limit • Select calculation methods of indicators proportional to the evaluation purpose • Measure indicators
3. FINDING ALTERNATIVE SOLUTIONS	• Define alternative management systems • Identify policy measures • Present results

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ORGANIC FOOD QUALITY AND PROCESSING

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Organic production extends across the whole world. According to current data [1], total organic agricultural land in 2014 covered 43,7 million hectares (in 1999 - 11 million ha). At the end of 2014 in Europe 11,6 million hectares of agricultural land were cultivated organically by almost 340.000 producers; 2,4% of the agricultural area was organic, contributing 27% of the organic land in the world. Organic agriculture in Europe is based on the legal framework of the Council Regulation (EC) No. 834/2007 [2] and Commission Regulation (EC) No. 889/2008 [3]. Organic production excludes any synthetic soil fertilizers and synthetic pesticides, as well as genetically modified organisms and their products. Instead, only natural fertilizers such as animal manure, compost or green manure are used. Biological methods of plant protection are also permitted.

According to many studies vegetables and fruits produced in the organic way have a different composition compared to the conventionally produced ones. They contain less residues of harmful pesticides, less cadmium and nitrates / nitrites, but more bioactive compounds, such as polyphenols, than their conventional counterparts [4]. Polyphenols play a key role in human health, providing a protection against many diseases [5]. The level of mycotoxins and bacteria is similar in organic and conventional crops. Some studies show that organic crops also contain more minerals such as copper, boron, zinc, phosphorus, potassium, magnesium and iron [6]. The level of sugars and organic acids is also higher in the organic crops according to some authors [7].

The main reason for the above composition differences is a different system of fertilization and plant protection between the organic and conventional farming practices; not only the dose but also the form of the nitrogen fertilizer used in plant production is especially important. According to the growth-differentiation balance hypothesis (GBDH) theory [8] plants cultivated with organic fertilizers direct their metabolism more into differentiation – they produce a wider range of different biochemical compounds. The plants fertilized with synthetic nitrogen fertilizers direct their metabolism more into growth – they achieve higher yields, but they contain lower diversity and concentrations of the beneficial biochemical compounds.

Not only plant foods have a different composition when produced within the organic system. This holds also for animal products such as milk and meat. According to the meta-analysis of Średnicka-Tober et al. [9] milk from organically raised cows contains significantly more total polyunsaturated fatty acids (PUFA) and n-3 PUFA than conventionally produced milk. Similarly, the meta-analysis on organic meat [10] indicated significant differences in fatty acid profiles between organic and conventional meat; the most significant differences were found for total PUFA and n-3 PUFA. The reason for these differences is a longer period of pasturage applied to organically reared animals compared to conventionally raised animals. Regular consumption of fresh herbage increases the levels of PUFA in organic milk and meat.

Rules for the processing of organic products are defined with the same regulations that apply to primary production. In accordance with the applicable legal regulation, organic products may be manufactured only from raw materials of organic origin, except when there is no organic equivalent of a necessary ingredient [11]. Non-organic agricultural ingredients may be used only if they have been authorised for use in organic production, or when they are used on the basis of a temporary permission issued by a Member State of the EU.

In the processing of organic foods microorganisms, enzyme preparations, natural flavours and dyes (e.g. ink used for the marking of meat and eggs) as well as water and salt, minerals, vitamins, amino acids and trace elements can be used. The rules also preclude the use of processing methods that can change the true nature of the product. Careful processing of food by means of mechanical, thermal, and fermentation methods is strongly recommended. In organic processing there is a strict ban on the use of genetically modified organisms and the products made from them or using them. Treatment of organic food with ionising radiation and chemical methods is also prohibited. Organic processed products should be produced by the use of processing methods which guarantee that the organic integrity and vital qualities of the product are maintained through all stages of the production chain.

To summarize, organic food has a different chemical composition compared to conventional food. It contains significantly less harmful substances (pesticides, cadmium, synthetic food additives) and oftentimes significantly more compounds beneficial for human health (polyphenols, some minerals, polyunsaturated fatty acids). Therefore it can be assumed that regular consumption of organic food should be positive for human health; this hypothesis needs to be verified in the future studies.

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AGROECOLOGY AND SUSTAINABLE FOOD SYSTEMS

Hélène Brives and Alexander Wezel

Agroecology has been defined variously as a science, as practices, and as a movement, depending on the country and organization that embraces this vision [1]. One overarching definition that has guided the development of agroecology in recent years is the 'ecology of food systems' approach [2, 3]. This moves beyond the context of the more material spatial scale of the field and farm agroecosystem with relatively defined borders and enters the wider dimensions of the food system (Figure 1).

Agricultural production should provide sufficient food for the world's population while being environmentally friendly, socially acceptable, and economically beneficial for farmers. In addition, food products should also be available at affordable prices for low-income populations without negatively impacting nutritional quality. The foundations of the agricultural model needed to achieve these goals lay within the different practices which farmers apply to crop and livestock production. Some of these practices can be considered as agroecological practices [4] if they effectively valorise ecological processes and ecosystem services through their integration as fundamental elements in the development of agricultural strategies. Furthermore, sustainable food systems have to be built so that they better connect farmers to consumers and that they establish supply chains where economic benefits are fairly shared among the stakeholders and along the chain.

Food systems with no or a maximum of one intermediary (short supply chains) succeed in re-connecting producers and consumers. Numerous initiatives flourish all over Europe such as farmers' markets, on-farm selling, community supported agriculture, food box schemes, and coop shops, but they represent only a tiny part of food flows. Nowadays a challenge is to re-establish this connection within mainstream food systems organized in long supply chains with several intermediaries (processors, logisticians, marketers, distributors, retailers…) and to develop mid-tier supply chains [5]. The issue is to maintain the link between food and its ecological and social conditions of production and transformation all along the chain (Figure 2). Telling the socio-ecological history of food, a sustainable food system is able to involve producers, consumers and other stakeholders feeling connected by shared values. Two examples are presented to illustrate this.

Figure 1 The food systems approach in agroecology. Food systems connect farmers, consumers, supply chain intermediaries and other stakeholders through food and agroecosystems. These systems are strongly influenced by different factors and impacts from policies, society, economy and environment.

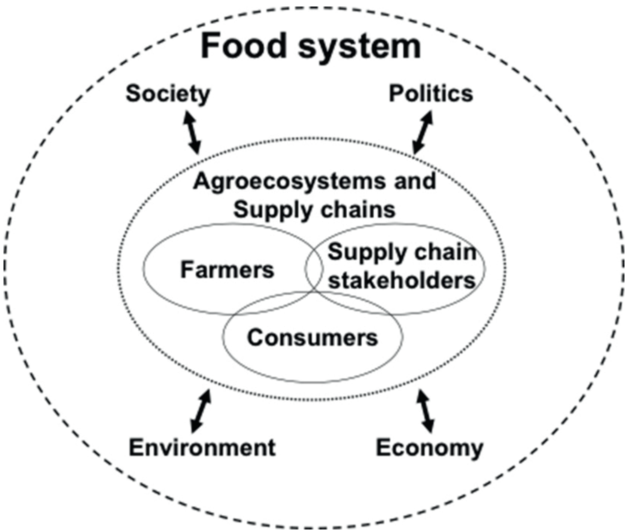

Figure 2 Short supply chains keep the link between food and its ecological and social conditions of production and transformation (Photo: Alexander Wezel)

The first example is about an initiative by a grain processor, the Dupuy Couturier mill in the department of Loire in France. This mill specializes in the production of organic flours and high quality flours. In 2017 this food system consists of 80 farmers producing CRC®-certified wheat (culture raisonnée controlée - controlled integrated agriculture with environmental requirements) on 7.000 ha, a cooperative that transports and stores the grains, the mill, and 120 bakers who produce the bread under the associated brand "Le Forézien" and sell it locally. The production comprises about 4.000 tons of grain and 2.500 tons of flour p.a. The CRC® certification, recognized by an official third party, guarantees the traceability of the products, defines the production characteristics (no traces of pesticide residues, wheat stored without treatment, and good environmental practices including recently added biodiversity objectives), and results in the 20% premium above commodity prices that the growers receive. Consumers appreciate the local origin and human scale of the supply chain in which all the participants know each other and work in partnership to ensure quality, traceability and food safety.

The second example is an initiative of cattle breeders and the urban community of Roanne in France selling "100% local beef burgers" that claims to support preserving the typical bocage landscape (mixed woodland and pasture), local economic activity and agriculture. They use Charolais cattle that are grass based fed and fattened on-farm. About ten breeders are involved together with a local slaughter house, a processor and 15 local supermarkets. All the partners agree on an economically viable price for breeders and everyone's commercial margins are discussed in the network.

These two examples show how a food system approach addresses a wide variety of issues related to organization between actors, negotiation, social relations, networking, employment, distribution of economic benefits as well as local and rural development. The challenge is to experiment with new practices on the farm but also outside the farm, in the factories, in the artisan production facilities and the offices, to establish new types of partnerships between all actors.

At a global scale, the food systems approach in agroecology also deals with a large variety of issues such as food sovereignty, alternative and local food networks, social agricultural networks, food crises, food security, right to food, and food markets [6, 7]. In conclusion, sustainable food systems have to be built on agroecological practices and production, in connecting farmers to consumers, and in developing supply chains where economic benefits are fairly shared among the stakeholders and along the chain.


Things That Grow
on Trees
NUTS:
Walnuts
Pecans
Almonds
Apples
Peaches
Pears

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CREATE
enter
return
alt
option

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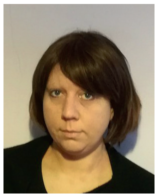

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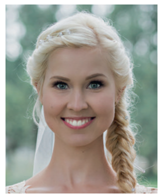

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Innovative Education towards
Sustainable Food Systems

ABOUT SUS+

Innovative Education towards Sustainable Food Systems (SUSPLUS) is a project that supports cooperation between eight European universities to develop, implement and widely disseminate innovative educational materials and methods in the subject matter of sustainable food systems. In the face of global population growth, resource constraints and growing environmental as well as public health concerns, there is a strong need for a shift towards more sustainable development. Most of these global problems are strongly influenced by unsustainable food systems therefore high priority is given towards developing strategies to improve sustainability of food production and consumption models. At the same time there are very few study programmes and modules targeting this important subject globally and sustainable food is still a niche market in many European countries, hardly supported by well-educated and skilled university graduates. SUSPLUS provides university students with necessary knowledge, competencies and skills to support this important sector, and contributes thereby to increase their employability. SUSPLUS is funded by Erasmus+, which is the European Union's programme to support education, training, youth and sport in Europe. It contributes to the Europe 2020 strategy for growth, jobs, social equity and inclusion, as well as the aims of ET2020, the EU's strategic framework for education and training. Erasmus+ also aims to promote the sustainable development of its partners in the field of higher education, and contribute to achieving the objectives of the EU Youth Strategy.

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